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on
COTTON INSECT RESEARCH AND CONTROL
BATON ROUGE, LOUISIANA
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This is a summary report of the Conference of Federal and State workers concerned with cotton insect research and control, held at Baton Rouge, Louisiana, November 8-10, 1948. It brings together the results of recent research and experience in the control of cotton insects.

The results summarized in this report will aid in the preparation of recommendations that may be issued by State agencies and the U. S. Department of Agriculture on cotton insect control for 1949. The report is being distributed to entomologists, research and extension workers, the insecticide industry, and others interested in cotton production. Copies are not available for general distribution.

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This report supersedes the report covering the Conference on Cotton Insect Control that was held at Stoneville, Mississippi, November 17-19, 1947.

Contents

Introduction

Research and extension entomologists from twelve cotton-growing States and the United States Department of Agriculture participated in a conference at the Louisiana Experiment Station, Baton Rouge, Louisiand, November 8-10, 1948,to review and summarize their experiments and experiences in cotton insect control and to formulate a guiding statement for control recommendations in 1949. After a review of all available information, the report that follows was unanimously approved by the conferees.

Cultural methods of controlling cotton pests are not considered in this report except for the pink bollworm. However, such methods cannot be too strongly emphasized. It should be recognized that control of cotton insects by the use of insecticides is really supplemental to the adoption of good farm practices. These include such factors as early fall clean-up, seed treatment, early planting, fertilization, use of proper cotton varieties, proper land use, and cultivation. Cultural measures are influenced by climate, soil conditions, fertility, topography, and geographical location.

In addition to recommendations for the use of certain insecticides for the control of cotton insects, the report presents information believed to be of value to industry in planning production programs and to cotton growers who may be contemplating trials of some of the insecticides that are still in an experimental stage. It contains some suggestions as to research needs in developing a more effective cotton insect control program. Control recommendations are presented in a general manner and are not specifically fitted to local needs. It is expected that each State in preparing recommendations for cotton insect control for 1949 will adapt to its own conditions the information given in this summary.

Hazards and Precautions in the Use of Insecticides for Cotton Insect Control

The development of the newer synthetic organic insecticides has provided more effective means of controlling insects but it has also intensified numerous problems, such as hazard to man, animals and crops. With few exceptions, all insecticides are poisonous to animals and man and because of this they should be used with appropriate precautions.

The factor of immediate toxicity of insecticides to the user, to livestock and to plants is of great importance. In addition, there is the effect of delayed toxicity due to repeated exposures, of accumulations of deposits in soils, and of residues on treated plants and on adjacent crops caused by drift. Users of insecticides should be thoroughly familar with the various hazards and should take proper precautions when formulating, packaging, labeling and applying the materials.

Precautions for the User

In considering the hazards to man it is necessary to distinguish between the immediate hazards (acute toxicity) and the accumulative effects (chronic toxicity). Research and experience to date indicate that new chlorinated organic insecticides are reasonably safe to man and the higher animals at strengths normally used for cotton insect control. On the other hand, the organic phosphorus containing insecticides are hazardous to the operator who handles and applies these materials. Continued contact with or exposure to insecticides with an apparently mild toxic index may result in an injurious accumulation of the toxic ingredient in the body.

Persons engaged in dusting operations should wear dust respirators or use a good substitute, such as padded cheesecloth, to avoid inhaling the poisonous dust particles. Loading and mixing should always be done in the open. Impervious gloves should be worm if it becomes necessary to handle the materials, but it is best to avoid any unnecessary contact with an insecticide. This applies to sprays as well as dusts. All empty containers in which the insecticides have been packaged should be burned or otherwise destroyed immediately after emptying. The insecticides should always be clearly identified by labels and stored in a place where they are inaccessible to irresponsible persons and to domestic animals. Both spraying and dusting operations hould be done under such conditions and in such a manner as to avoid excessive drift to adjacent fields where animals are pastured or where food crops are grown. The operator should be familiar with first aid measures. As soon as possible after the spraying or dusting operations are concluded, the operator should bathe and change clothes. Spillage of insecticides where they might contaminate water used by man or livestock should be avoided. Any excess dusts or sprays even in small quantities should be deeply buried.

Certain varieties of plants and kinds of crops are injured by insecticides. Therefore, care sould be exercised to prevent drift of insecticides from the treated fields to adjacent fields.

Residues in Soils

The effect of insecticides on germination, rate of growth, and flavor of crops may be influenced by type of insecticide, formulation used, soil type, kind of plant, and concentrations of residue in the soil. Information to date indicates that in the amounts and concentrations recommended for cotton there is no immediate hazard involved. Injury to several crops by higher rates of application of some insecticides on certain soil types has been demonstrated. There is a great need for extensive research on many soil types with a variety of crops to determine as soon as possible the effect of continued use of these materials on germination and plant growth, and the possible plant assimilation of these chemicals or their

by-products which might later be eaten and stored in toxic quantities in the bodies of man and domestic animals.

Safeguarding Beneficial Forms of Life

Insecticides destroy beneficial as well as injurious insects. Care should be exercised to avoid poisoning honey bees through careless use of insecticides. Nearby bee keepers should be notified before dusting whenever possible. Certain of these materials are also highly toxic to various forms of aquatic life. It is especially necessary to use minimum amounts in cases where there would be an unavoidable drift to ponds and streams. The same precautions should be followed in avoiding pollution of streams, and farm ponds stocked with fish by careless dumping of excess spray or dust materials or when cleaning dusting or spraying equipment.

Insecticides

Benzene Hexachloride

Benzene hexachloride controls the boll weevil, cotton aphid, cotton fleahopper, tarnished plant bug, rapid plant bug, cotton leafworm, thrips, southern green stink bug, garden webworm, and fall armyworm. It does not control the bollworm, pink bollworm, salt marsh caterpillar, and red spider mites. In many instances its use has resulted in greatly increased numbers of bollworms and red spider mites. For these reasons, benzene hexachloride alone frequently cannot be successfully employed for overall cotton insect control. Benzene hexachloride also kills many beneficial insects.

Benzene hexachloride at approximately one-third pound gamma isomer per acre (example: 10 pounds of benzene hexachloride dust containing 3 percent of the gamma isomer) is the minimum rate which has consistently given satisfactory control of the insects against which it is effective. The most common commercial benzene hexachloride dust formulation used by cotton growers contains 3 percent gamma isomer and 5 percent DDT. In areas where red spider mites are a problem 40 percent sulfur should be used in the mixture.

When the mixture of 5 percent DDT and benzene hexachloride (3 percent gamma isomer) is used, an average of 10 pounds of dust per acre is recommended for control of the boll weevil and other insects except the bollworm. Where the bollworm is also a problem, the rate should be increased to 15 pounds per acre. Applications should usually be made at 4 to 5 day intervals until the infestation is brought under control. The use of this mixture destroys natural enemies of the bollworm and this insect may increase rapidly following a premature termination of a dust program. One application of 15 pounds of the mixture per acre may suffice for "knock out" aphid control.

Sulfur, pyrophyllite, and non-alkaline clays and talcs have been used as satisfactory diluents for benzene hexachloride.

Further research is needed on the accumulation of this insecticide in the soil following applications to cotton and the resultant effect on other crops. Grain sorghum, Irish potatoes, onions and sweet potatoes are some of the crops adversely affected by benzene hexachloride.

High temperatures, wind, and convection currents greatly reduce the effectiveness of benzene hexachloride for aphid control.

Technical benzene hexachloride has an objectionable odor and is irritating to the eyes and nasal passages, but further injurious effects have not been experienced from repeated exposure of several hours at a time over a period of several weeks. Little is known of possible cummulative effects over a longer period. Its toxicity to birds, mammals, and fish is little known.

Calcium Arsenate

Calcium arsenate is an economical and effective insecticide for the control of the boll weevil and cotton leafworm. It gives fair control of the bollworm when heavy poundages are used and infestations are light. It will not control the pink bollworm, cotton aphid, and red spider mites. Calcium arsenate is usually used undiluted for boll weevil, bollworm, and cotton leafworm control. Formulations containing sulfur are used for cotton fleahopper control and to prevent build-up of heavy infestations of red spider mites. Formulations of calcium arsenate containing benzene hexachloride, nicotine, or rotenone, are used for cotton aphid control.

When calcium arsenate is used without an aphicide, an increase in the aphid population often results.

Mixtures of some kinds of calcium arsenate with benzene hexachloride have been used successfully for the control of the boll weevil and the cotton aphid. Most calcium arsenates are not compatible with benzene hexachloride.

Calcium arsenate at 7 to 10 pounds per acre will control the boll weevil and cotton leafworm. At 12 to 16 pounds per acre it will control the bollworm, if applications are properly timed and infestations are not too heavy.

When used for control of the cotton fleahopper, tarnished plant bug, and rapid plant bug, a mixture composed of two-thirds sulfur and one-third calcium arsenate should be used at a rate of 16 pounds per acre.

Calcium arsenate in certain light sandy soils is injurious to some crops, especially legumes and oats. It should not be used for cotton insect control in fields where rice may be planted. Drifting of the dust may injure soybeans and peach trees. Calcium arsenate is poisonous and should be handled carefully. Livestock should be kept out of dusted fields. Care should be taken to avoid drift when dusting near pastures, especially when airplanes are used. Calcium arsenate has excellent dusting qualities, and is recommended as a standard of comparison with organic insecticides against cotton insects for which it is effective.

Chlordane

Chlordane was tested extensively in 1948 against many insects injurious to cotton.

Chlordane was effective against the cotton fleahopper, tarnished plant bug, grasshoppers, and thrips. In Texas, 10 percent chlordane dust was effectively used for the control of grasshoppers in pastures adjacent to cotton. For the insects against which chlordane is effective, from 0.5 to 1.0 pound of technical material (example: 5 to 10 pounds of 10 percent chlordane dust) per acre is required. Conflicting results were obtained regarding the practical benefit of killing weevils in squares and bolls.

In general, the results obtained with chlordane against boll weevils were variable. Chlordane did not control bollworms and red spider mites, and, in many instances, these pests increased following its use. However, when 5 percent DDT was added good bollworm control was obtained, and when 40 percent sulfur was added to the chlordane-DDT mixture and used in all applications, red spider mite infestations did not develop. Chlordane failed to control heavy aphid populations, but injurious infestations did not develop following its use unless it was mixed with DDT.

The toxicity of chlordane to higher animals is of about the same order as DDT. Operators should avoid breathing the dust any more than absolutely necessary. Contamination of food and feed crops around cotton fields should be avoided. It is toxic to parasites and predators.

Little is known regarding possible ill effects on plants from accumulations in soils.

Chlorinated Camphene

Chlorinated camphene will control the boll weevil, bollworm, fall armyworm, cotton fleahopper, thrips, cotton leafworm, and grasshoppers. Two pounds per acre of the technical material (example: 10 pounds of 20 percent dust) is required for all these pests, except the cotton fleahopper and thrips which may be controlled with 1.0 pound of technical chlorinated camphene per acre (example: 10 pounds of 10 percent dust) and grasshoppers with 1.5 pounds per acre.

Satisfactory suppression of the cotton aphid resulted where chlorinated camphene was used throughout the season. It will not "knock out" heavy infestations. It will not control red spider mites and its use may result in their increase, unless the dust contains at least 40 percent sulfur.

Non-alkaline diluents, such as pyrophyllite, sulfur, talcs and others are suitable carriers for chlorinated camphene. Further studies are needed on the compatibility of this insecticide with diluents and also with other toxicants. Because of inherent difficulties encountered in making satisfactory dusts with this chemical processors and mixers are urged to give special attention to this matter and place on the market only formulations with good dusting properties.

Chlorinated camphene kills many of the beneficial insect predators and parasites.

No economic injury to cotton has been reported from the use of this insecticide. Further studies are needed on its toxicity to plants and animals. However, preliminary information indicates that this material breaks down more rapidly in the soil than some of the other chlorinated hydrocarbons.

Chlorinated camphene should be kept away from food and feed, and should be handled as a poison. The acute oral toxicity of this material is greater than that of other chlorinated hydrocarbons, but its sub-acute or chronic toxicity is low.

DDT

DDT is useful for the control of the bollworm, pink bollworm, cotton fleahopper, tarnished plant bug, rapid plant bug, and thrips. It is not an effective control for the boll weevil, cotton leafworm, red spider mites, cotton aphid, and grasshoppers.

In general, DDT is used as a dust for cotton insect control at concentrations of not less than 5 percent or more than 10 percent either alone or in admixture with other insecticides, and at rates of 10 to 15 pounds per acre. Bollworm and pink bollworm infestations require the higher rates of application; the lower concentrations and rates are effective for most of the other insects named. DDT failed to control thrips at temperatures above 90° F.

DDT, like calcium arsenate, often increases aphid populations to a point where severe damage may occur unless some aphicide is included. Following the use of DDT as a dust either alone or in combination, bollworm infestations sometimes occur after treatments are discontinued.

Sulfur, pyrophyllite, neutral talcs, neutral clays, or other neutral or slightly acid materials may be used in the formulation of DDT mixtures. Alkaline diluents should not be used. DDT is compatible with benzene hexachloride, chlordane, chlorinated camphene, and parathion, and formulations with these materials are unlikely to injure cotton.

DDT is toxic to certain plants and, if used in excessive quantities, accumulations in the soil may become toxic to others, especially in light sandy soils lacking humus.

In dusting, contamination of adjacent crops from drift should be avoided.

Parasites and predators of insect pests are, in general, susceptible to DDT, and biological control is seriously impaired following its use.

DDT is highly toxic to fish and amphibians, and precautions should be taken to preclude the possibility of stream pollution.

While acute toxicity of DDT to man and animals is rather low as compared with many inorganic insecticides now in use, caution should be exercised in handling it. Little is known of the cumulative effects of

repeated small dosages to man or domestic animals, and for that reason, it should be handled with the same precautions as inorganic insecticides.

The following phases of research should be emphasized: new uses; the cause of increase of aphid populations where DDT without aphicides is used; new mixtures with organic and inorganic insecticides; combined effects of DDT and other materials, whether additive or synergistic; compatibility with diluents and other insecticides; toxicity to insects, especially by comparisons of cage and field tests, and of the effects of temperature, humidity or other factors not immediately controllable; residual toxicity to insects; and contamination of crops used as food by man or animals.

Diluents, Solvents, and Accessory Materials

None of the new synthetic insecticides are used as undiluted toxicants. In dusts they are used in combination with carriers, such as talcs or clays, or in combination with other insecticides. Materials for the control of cotton insects have usually been applied in the dust form but they may also be applied as sprays. The new organic insecticides may be used either in oil solutions, aqueous emulsions or dispersed in water. Whether applied as a dust or as a spray, too much emphasis cannot be placed upon proper formulations.

A large proportion of the synthetic insecticide formulations available in many areas and states of the Cotton Belt possess very poor dusting qualities. In some instances research workers have attributed erratic results and poor control of cotton insects to the inferior dusting qualities of the insecticide. The poor physical condition of some of the commercial preparations no doubt account for many of the failures experienced by cotton growers.

One of the pressing needs concerning insecticidal formulations is to establish criteria for suitable organic dust mixtures. Among other features this might include flowability, adherence, density, and particle size. Further research is needed to determine the most desirable carriers, stickers, solvents, emulsifiers, and dispersing agents.

Although sulfur is not the most desirable diluent from a physical standpoint, it is recommended for use in those areas where red spider mites are usually a problem. Only a properly conditioned grade of dusting sulfur should be used in the formulations.

Dinitro Compounds

Dinitro insecticides are effective in the control of certain red spider mites. In laboratory tests dinitro-o-cyclohexylphenol was effective against the red spider mite Septanychus n. sp. when applied as one-half percent dust at a rate of 10 pounds to the acre. In comparable laboratory tests dinitro-o-cresol dusts were as effective as dinitor-o-cyclohexylphenol dusts. Results with dinitro-o-cyclohexylphenol in the field

were frequently unsatisfactory perhaps because of poor dusting qualities and poor plant coverage. At the rates tested, these compounds were not injurious to the cotton plant.

Ditolyl Trichloroethane

Ditolyl trichloroethane was used against cotton insects in laboratory and cage tests only. It was somewhat less effective against the cotton fleahopper than DDT, and dust concentrations of 5 to 20 percent were ineffective against the boll weevil, bollworm, cotton aphid, and garden webworm.

Heptachlor (E-3314), Velsicol 104, and Julius Hyman 118

The material designated as E-3314 in the report of the Stoneville conference has also been referred to as Velsicol 104, and in literature as heptachlor. It is a chlorinated hydrocarbon related to chlordane. The chemical designated as Julius Hyman 118 belongs to the same general group and has been available for testing only during the 1948 season. These materials have been tested against several species of cotton insects in laboratory and cage tests and in limited field experiments. In the laboratory and cage tests these compounds were highly effective against the cotton fleahopper at concentrations as low as 1.25 percent. Variable results were obtained in cage tests against boll weevils. There are indications that the effectiveness of heptachlor and 118 against the boll weevil is reduced when temperatures are high.

In laboratory tests, dusts containing 2.5 percent of heptachlor or 118 were effective against the larval and pupal stages of the boll weevil in squares and bolls. The action of these compounds, as indicated in these tests, appeared to differ from that of chlordane, which allows the immature forms to develop, but paralyzes the adults. However, in squares treated in the field with 118, the action was similar to chlordane.

Laboratory results indicated that dusts containing from 2.5 to 10 percent of heptachlor or 118 were less effective than insecticides now recommended for control of the bollworm, cotton aphid, cotton leafworm, and red spider mites.

These materials appear to be compatible with DDT, benzene hexachloride, and sulfur and present indications are that heptachlor or 118 will be more useful in combination with one or more of these insecticides than when used alone. Satisfactory control of boll weevils and bollworms was obtained with a mixture containing 2.5 percent of 118 and 5 percent of DDT in a field plot experiment.

Heptachlor and 118 have been available in limited experimental quantities, and further research is needed before their possible usefulness can be indicated.

These materials are said to be highly toxic to warm-blooded animals and are considered hazardous to use. Extreme precautions should be followed when they are used experimentally.

Hexaethyl Tetraphosphate

The insecticidal principle of hexaethyl tetraphosphate has been shown to be tetraethyl pyrophosphate. See paragraph on tetraethyl pyrophosphate.

Methoxychlor

Methoxychlor, or bis (methoxyphenyl) trichloroethane, the methoxy analog of DDT, as a 5 percent dust, was effective against the cotton flea-hopper in laboratory tests, but was slightly less effective than DDT. Methoxychlor was less effective than the insecticides now recommended for the control of the boll weevil, bollworm, cotton aphid, garden web-worm, red spider mites, and stink bugs.

In field tests, a dust mixture containing 20 percent methoxychlor with 40 percent sulfur failed to give satisfactory control of the boll weevil when applied at 15 pounds per acre per application. In one experiment there was a heavier aphid build-up with methoxychlor than with DDT. Dusts containing 10 percent methoxychlor controlled the cotton leaf-worm, but lower concentrations gave poor control.

A combination dust containing 10 percent methoxychlor, 2 percent gamma benzene hexachloride and 40 percent sulfur applied at the rate of 15 pounds per acre gave fairly good boll weevil control, but failed to control the bollworm. Methoxychlor gave slightly better pink bollworm control than DDT.

Toxicological studies indicate that this material is less toxic to warm-blooded animals than DDT.

Nicotine

Two percent nicotine in alternate applications of calcium arsenate (the period between nicotine applications not to exceed 8 to 10 days), or one percent in each application of calcium arsenate if properly applied will usually prevent a cotton aphid build-up.

Either two or three percent nicotine in a suitable carrier can be used to ''knock out'' heavy aphid infestations. At least 0.2 of a pound per acre of free nicotine equivalent should be applied. The source may be either nicotine sulphate or a fixed nicotine in dust form.

Applications of nicotine dust to "knock out" heavy aphid infestations should be applied when the air is calm and preferably when there is no dew on the plants. Complete coverage is essential.

Nicotine is highly toxic to man and animals and should be used with proper precautions.

Parathion

Experimental results show that 1 percent parathion dust is effective against the cotton aphid, red spider mites, garden webworm, and some species of thrips. Two percent dust was effective against grasshoppers and the fall armyworm. Parathion has been found to exert very little control against the boll weevil, bollworm, and pink bollworm.

The data available on the toxicity of parathion to higher animals do not justify including this insecticide in control recommendations for cotton insects in 1949. This material is highly toxic to warm-blooded animals, including humans, and is considered hazardous to use. Extreme precautions should be followed even when it is used experimentally. Apparently residues on plants do not persist more than a month.

Piperonyl Compounds

Dusts containing piperonyl cyclonene or piperonyl butoxide as the only toxicant were tested against cotton aphids in the laboratory. Neither compound was effective against cotton aphids when applied as a dust at concentrations ranging from 0.125 to 4 percent. Neither compound caused any increase in the effectiveness of chlorinated camphene, chlordane, benzene hexachloride, DDT, nor Ryania against cotton aphids when mixed with these materials at 2 percent concentration.

Piperonyl butoxide did not increase the effectiveness of pyrethrins or rotenone against cotton aphids. At higher concentrations it appeared to render both insecticides virtually ineffective. A dust mixture containing 0.25 percent rotenone and 1 percent piperonyl cyclonene appeared about equal to 1 percent rotenone against the aphids. Other mixtures were less effective.

Piperonyl cyclonene alone and in combination with rotenone and with pyrethrins were relatively ineffective against red spider mites in laboratory tests.

Rotenone, Pyrethrum, Ryania, and Sabadilla

There appears to be little reason for recommending these plant materials for cotton insect control at present since some of the newer synthetic organic insecticides that are more readily available and cheaper appear to be effective. A mixture containing calcium arsenate and 1 percent rotenone at each application made against the boll weevil has given satisfactory cotton aphid control.

Sulfur

Sulfur has been widely used on cotton for control of red spider mites and the cotton fleahopper. When used in dust mixtures it often has a repressive effect upon aphid populations. In areas where red spider mites are likely to be a serious problem, 40 percent or more sulfur should be included in organic insecticides used on cotton to prevent the development of damaging infestations of these pests. Properly conditioned dusting sulfur may be used as a diluent for other insecticides when a non-alkaline or an acid carrier is desirable.

TDE (DDD)

TDE, also known as DDD, or 1,1-dichloro-2, 2-bis (p-chlorophenyl) ethane is an analog of DDT. TDE has been tested against cotton insects only in laboratory and cage tests. When used as a 20 percent dust TDE killed the boll weevil and bollworm but it was less effective against these insects when applied as a 10 percent dust. Cotton leafworms were killed with a 10 percent dust. TDE was slightly less effective than DDT against the cotton fleahopper. TDE as a 10 percent dust had little effect against the cotton aphid, garden webworm, red spider mites and the southern green stink bug.

In field tests against the pink bollworm TDE did not give as good control as DDT.

Tetraethyl Pyrophosphate

Tetraethyl pyrophosphate showed promise as an aphicide on cotton in tests during 1948. The mixture tested consisted of 0.1 pound of technical material in 1.9 gallons of water per acre applied by airplane. In view of the very promising results, and also due to the fact that tetraethyl pyrophosphate is known to be an effective miticide, it should be further tested, especially in sprays having a higher concentration of tetraethyl pyrophosphate. Like hexaethyl tetraphosphate, tetraethyl pyrophosphate deteriorates very rapidly when exposed to moist air and is incompatible with alkaline materials. Because of its toxicity to warm-blooded animals extreme care should be exercised in its use. The data available do not justify including this material in control recommendations for cotton insects in 1949.

Sprays for Cotton Insect Control

The limited research to date does not warrant recommendations for the use of organic insecticides in the form of sprays for cotton insect control during 1949.

Preliminary tests with several organic insecticides applied in spray form by airplanes for cotton insect control gave promising results in 1948 Other tests with sprays applied by ground equipment gave very erratic results which were generally poor

Extensive research is needed on the use of organic insecticides as sprays for cotton insect control.

Bug Catching Machines

Bug catching machines did not significantly affect either boll weevil infestations or cotton yields in the experiments conducted during 1948 at Aberdeen, Mississippi, and Shreveport and Tallulah, Louisiana.

Beneficial insect populations (particularly lady beetles) were materially lowered by the operation of the machine. The percentage of reduction of injurious insects which was attributable to the operation of the machine was negligible from the standpoint of control of cotton pests.

Bug catching machines are not recommended as a means of controlling cotton insects.

Chemical Defoliation of Cotton

Defoliation of cotton with chemicals has been considered more from the standpoint of mechanical picking and reduction of boll rot than as an aid to insect control. However, there has been enough work done on defoliation with calcium cyanamid in relation to cotton insect control to warrant systematic investigations.

Damage to open cotton by heavy aphid populations which developed late in the season was prevented by defoliation; likewise, damage from late leafworm infestations was also prevented. Early fall defoliation reduced the percentage of looks infested by boll weevils. Observations indicated that defoliation caused boll weevils to leave cotton fields immediately. It is apparent that a more comprehensive study of defoliation in relation to cotton insect control is needed.

The search for defoliants should be continued, especially for one suitable to the arid west and the southwest for use in connection with pink bollworm control. Time of application of defoliants in relation to crop development and other factors should be further investigated.

Cotton Insects

Boll Weevil

The boll weevil, Anthonomus grandis Boh., may be effectively controlled with benzene hexachloride, calcium arsenate, or chlorinated camphene applied as a dust. Benzene hexachloride should be applied at the rate of 0.3 pound gamma isomer (example: 10 pounds of 3

percent dust) per acre, calcium arsenate at the rate of 7 to 10 pounds per acre, and chlorinated camphene at the rate of 2 pounds of the technical material (example: 10 pounds of 20 percent dust) per acre. When these insecticides are used for boll weevil control under field conditions, other insect problems have to be considered. Complications involving the cotton aphid, bollworm, and red spider mites may develop when some of these insecticides are used alone for boll weevil control.

Dusts containing ten percent chlordane have given good control of the boll weevil in some instances, but in other cases very erratic results have been obtained. Additional research is needed before specific recommendations can be made on this material.

Formulations recommended to farmers for general use include (1) a dust containing technical benzene hexachloride (3 percent gamma isomer) - 5 percent DDT mixture; (2) calcium arsenate containing 1 percent nicotine in every application; (3) calcium arsenate applied alternately with calcium arsenate - 2 percent nicotine; (4) calcium arsenate applied alternately with technical benzene hexachloride (3 percent gamma isomer) - 5 percent DDT; (5) technical benzene hexachloride (1 percent gamma isomer) in special low-lime calcium arsenate in every application; (6) technical benzene hexachloride (2 percent gamma isomer) in special low-lime calcium arsenate in alternate applications with calcium arsenate; and (7) 20 percent chlorinated camphene. In areas where red spider mites are a factor, dust formulations of organic insecticides should contain at least 40 percent sulfur.

Control measures should be applied only when definite need is indicated. All insecticides should be applied at intervals of 4 to 5 days until the infestation is brought under control. Usually three or more applications are required. Thereafter, weekly inspections should be made and subsequent applications made when necessary.

Bollworm

Serious outbreaks of the bollworm, Heliothis armigera (Hbn.), on cotton occur periodically in most states of the Cotton Belt. Causes of outbreaks are complex, some of which are as follows:

1. Changes in cropping systems. Increased acreage of the crops which are hosts of the bollworm, such as alfalfa, grain sorghums and soybeans are being grown. There may be times when these crops serve as hosts to increase bollworm populations, while at other times they may act as trap crops, depending on the time of planting, dates of maturity of the crop, and seasonal variations.
2. Insecticides. Low populations of natural enemies of bollworms resulting from the use of some insecticides allow outbreaks to develop.
3. Climatic conditions.

The bollworm may be controlled with 10 percent DDT, 5 percent DDT plus technical benzene hexachloride containing 3 percent gamma isomer, or 20 percent chlorinated camphene. Calcium arsenate, lead arsenate, and cryolite are less effective. Whenever red spider mite control is also necessary, any mixture containing organic insecticides should include at least 40 percent sulfur.

All dusts should be applied at the rate of 10 to 15 pounds per acre at each application, the amount depending upon weather conditions, the intensity of the infestation and size of the cotton. Applications should begin when eggs and 4 or 5 small bollworms per 100 terminals are found, and should be continued at 5 day intervals until the infestation is brought under control.

Successful control of the bollworm is dependent upon <u>timeliness of application</u> and <u>thorough coverage</u> of the cotton plant throughout the period of injurious infestation.

Cotton Aphid

Heavy infestations of the cotton aphid, *Aphis gossypii* Glov., often follow the use of calcium arsenate or DDT on cotton. Injurious infestations seldom occur on fruiting cotton unless some insecticide has been used for control of another insect. Infestations often occur on seedling cotton.

The following insecticides and combinations will prevent an aphid build-up, if properly applied under favorable conditions:

One percent of nicotine in every application of calcium arsenate or two percent in alternate applications.

Benzene hexachloride mixtures, in every application or alternate applications, applied at the rate of one-third pound of the gamma isomer per acre.

Chlorinated camphene applied at the rate of 2 pounds of technical material per acre in every application.

One percent gamma benzene hexachloride in every application of special neutral or low-lime calcium arsenate, or 2 percent gamma benzene hexachloride in alternate applications.

One percent of parathion in some calcium arsenates. (This mixture should be restricted to experimental use.)

The following mixtures will control heavy infestation of aphids, if properly applied under favorable conditions:

Benzene hexachloride applied at the approximate rate of one-half pound of the gamma isomer per acre.

Two or three percent of nicotine in a suitable carrier.

One percent of parathion in inert diluents. (This mixture should be restricted to experimental use.)

Cotton Fleahopper, Tarnished Plant Bug,
Rapid Plant Bug, and Other Mirids

The cotton fleahopper, Psallus seriatus (Reut.), has been controlled with chlorinated camphene 10 percent, DDT 5 percent plus sulfur 75 percent, technical benzene hexachloride containing 1 percent gamma isomer, or chlordane 2 percent. Less effective control may be obtained with sulfur alone, or sulfur-calcium arsenate mixture 2:1. When red spider mites are likely to be a serious problem 40 percent or more sulfur should be added to organic insecticides.

For control of the tarnished plant bug, Lygus oblineatus (Say), and the rapid plant bug, Adelphocoris rapidus (Say), higher concentrations of the above mentioned organic insecticides may be required. Dusts containing technical benzene hexachloride with three percent gamma isomer are effective for control of the adult tarnished plant bug.

Cotton Leafworm

The cotton leafworm, Alabama argillacea (Hbn.), has been controlled successfully for many years by calcium arsenate, paris green or lead arsenate. Dust formulations of technical benzene hexachloride containing three percent gamma isomer, 20 percent chlorinated camphene, or a mixture of 5 percent DDT plus 3 percent gamma benzene hexachloride are also effective in controlling the cotton leafworm.

Cutworms

Cutworm outbreaks may develop in weeds or crops, especially legumes. Cutworms migrate to adjacent cotton or attack cotton planted on land previously in weeds or legumes.

Recommended control measures are thorough seed-bed preparation and use of poison-bran bait. Paris green and sodium fluosilicate are satisfactory poisons to include in the bait. A poison bait consisting of 40 percent cryolite and citrus meal gives effective control.

Recent work on other crops has shown that 10 percent DDT is an effective insecticide for certain species of cutworms. Where the granulate cutworm, Feltia subterranea (F.), is involved, 20 percent DDT or 20 percent chlorinated camphene is recommended.

Fall Armyworm

The fall armyworm, Laphygma frugiperda (A. & S.), occasionally occurs in sufficient numbers to damage cotton. Dusts containing 20 percent chlorinated camphene, technical benzene hexachloride containing 3 percent gamma isomer - 5 percent DDT - 40 percent sulfur,

10 percent chlordane, or 10 and 20 percent DDT have given good control. Five percent DDT will control small worms. These insecticides should be applied at the rate of 20 pounds per acre. The results obtained from the above materials have varied in different states. Local recommendations are advisable.

Garden Webworm

The garden webworm, Loxostege similalis (Guen.), may be controlled on cotton by dust mixtures containing 5 percent DDT and benzene hexachloride containing 3 percent gamma isomer, 20 percent chlorinated camphene, or 10 percent DDT. DDT is generally less effective than the other two materials. DDT has given better control in sprays than in dusts. Calcium arsenate may also be used for control of the garden webworm, but heavy poundages are required, and control is generally less satisfactory than with the new organic insecticides.

Grasshoppers

Chlordane, chlorinated camphene, or benzene hexachloride applied as sprays or dusts are rapidly replacing poison baits for grasshopper control in many areas. This is particularly true where grasshoppers must be controlled on lush or dense vegetation, in inaccessible areas. and under small field conditions where the use of mechanical bait spreaders is impractical.

Benzene hexachloride sprays and dusts produce a spectacular kill in a few hours but residual effectiveness is limited to one or two days. Chlordane and chlorinated camphene on the other hand are slow in their action but remain residually effective 5 to 14 days depending on prevailing environmental conditions.

Dosages usually recommended fall within the following ranges:

Gamma isomer benzene hexachloride	0.3-0.5 pound per acre
Chlordane	0.5-1.5 pounds per acre
Chlorinated Camphene	1.0-2.5 pounds per acre

In general, sprays are more effective than dusts and in many states the dosage rate is increased when dusts are used. Results obtained with dusts are reportedly erratic particularly when rain occurs within 24 to 48 hours, whereas sprays retain most of their effectiveness if the spray mixture has become dry before the rain.

The lowest dosage rates suggested are effective on newly hatched to half grown hoppers but the dosage should be increased as the grasshoppers mature or when applied on unpalatable or partly defoliated plants.

Baits made according to state or federal recommendations still have a place in grasshopper control where extensive treatment is required.

Pink Bollworm

Cultural practices including regulated dates for planting and destruction of cotton stalks remain the most effective means of combatting the pink bollworm, Pectinophora gossypiella (Saund.). The stalks should be destroyed not later than ten days prior to frost. Earlier stalk destruction will give better control of hibernating larvae and reduce the number of pink bollworm generations per season. The harvest and subsequent creation of a host-free period in south Texas should be expedited by defoliation of the plants when necessary.

In areas where the harvest must be completed after frost, it is recommended that as many bolls as possible be removed from the plants by snapping or mechanical harvesting and that stalks be left standing during the winter months. The highest mortality of hibernating larvae in such areas is obtained in bolls on standing stalks.

Winter mortality of hibernating larvae has been found to be much greater in south Texas and adjacent areas of Mexico when bolls and trash are ploughed under to a depth of six or more inches in late summer or early fall. Regulatory measures such as heating of the cotton seed and sanitary practices at processing plants assist in suppressing local infestations and preventing artifical dissemination.

DDT continues to be the best insecticide for control of the pink bollworm. The use of methoxychlor results in a greater build-up of aphids and does not control the bollworm, Heliothis armigera (Hbn.). Consequently, DDT is the preferred insecticide although it gives no better control of the pink bollworm than does methoxychlor.

Formulations should contain not less than 10 percent DDT and should be applied at the rate of 15 pounds of dust per acre every 7 days. It is often necessary in the general control program that heavy infestations of the pink bollworm be reduced quickly. In such instances, 20 percent DDT should be applied at the rate of 15 pounds per acre at 7-day intervals until the infestation is brought under control.

Aphids and red spider mites may develop when DDT is used with only an inert carrier for pink bollworm control, and it is therefore advisable to incorporate other insecticides in the dust formulations to control these pests. The best combination is a mixture of 10 percent DDT, 2 percent gamma benzene hexachloride, 40 percent sulfur and a good conditioner such as inert clay or pyrophyllite. In the presence of heavy boll weevil infestation, it will be necessary to increase the gamma benzene hexachloride content from 2 to 3 percent.

Any insecticide used for pink bollworm control should be applied at weekly intervals and in such quantities that not less than 1.5 to 3 pounds of technical DDT is used per acre at each application. The cotton plants must be thoroughly covered with the insecticide and the applications made at the suggested intervals to obtain the most efficient control. Considerable difficulty has been encountered in maintaining the proper dusting schedules

in the southwest and it is believed the development of adequate spray machinery is essential to secure the pink bollworm control needed in those areas.

The pink bollworm is considered the most serious insect pest of cotton in India, China, Brazil, Argentina, and Egypt. Records in the United States show that the pink bollworm has survived a temperature of -6° F., and that emergence has occured in the semi-tropical areas of south Texas as long as $12\frac{1}{2}$ months after the larvae entered hibernation. The control programs of the United States Department of Agriculture in cooperation with the affected states and Mexico should be strengthened and research continued in order to prevent additional spread of the pink bollworm which is now confined to four southwestern states and Florida.

Red Spider Mites

At least four species of red spider mites are known to attack cotton. *Tetranychus atlanticus* McG. was recorded from California and South Carolina during 1948, and was reported to be the most widespread mite on cotton in California. *Tetranychus bimaculatus* Harvey was recorded from South Carolina, Mississippi, Louisiana, Arkansas, Texas (in a greenhouse), and California. *Tetranychus* sp. ("nearest *bimaculatus* but differing" McGregor) was recorded from Mississippi. *Septanychus* n. sp. was recorded from Mississippi (in a greenhouse), Texas (the only species of mite found in the field), and Arizona. McGregor, who is describing the species, states "it has now been received from six states, more often on cotton." *T. bimaculatus* is apparently the most important species occurring on cotton from Louisiana eastward. *Septanychus* n. sp. is the most important species occurring on cotton in Texas and Arizona.

Control of red spider mites on cotton has been variable. Sulfur has at times failed to give adequate control of *T. bimaculatus*. Sulfur at 20 pounds per acre and 1 percent dinitro-o-cyclohexylphenol at 10 pounds per acre was effective against *Septanychus* n. sp. in laboratory tests in Texas. Field control with DN was not as good as laboratory control, but this might have been due to the very poor physical qualities of the dusts. A dust mixture containing one-half percent parathion gave high initial kill of *Septanychus* n. sp. in both laboratory and field tests in Texas, but in field experiments it was not as residually effective as sulfur.

Although sulfur has at times failed to give adequate control of red spider mites, it is the most effective insecticide which may be recommended at this time.

In areas where red spider mites are a factor dust mixtures of organic insecticides used against other cotton insects should contain at least 40 percent sulfur to prevent red spider increase.

Thrips

Thrips may be controlled with dusts containing 10 percent chlorinated camphene, 10 percent chlordane, or 1 percent gamma benzene hexachloride applied at 12 to 15 pounds per acre. A mixture of 5 percent DDT and 0.5 percent gamma benzene hexachloride is also effective, if used when the temperature is less than 90° F. In areas where red spider mites are a problem, 40 percent sulfur should be added to any insecticides used for thrips control. Thrips injury to cotton is often associated with the maturity of oats and, at that time, special attention should be given to thrips on cotton.

Tobacco Budworm

The tobacco budworm, *Heliothis virescens* (F.), was reported infesting cotton from several localities in the Cotton Belt during 1948. Its injury was similar to that of the bollworm. Little evidence is available as to the amount of injury caused by this species in relation to that caused by the bollworm. Information is needed on seasonal history, life history, host plant preferences, seasonal and geographical distribution, and susceptibility to the more commonly used insecticides.

Wireworms

Several species of wireworms are associated with cotton. Perhaps the most noticeable damage is caused by the sand wireworm, *Horistonotus uhlerii* Horn., in South Carolina, Louisiana, and Arkansas. Adults of the tobacco wireworm (spotted click beetle) *Conoderus vespertinus* (F.), are frequently found on the cotton plant but the amount of damage caused by the larvae of this species is not known.

Approved crop rotation practices, increased soil fertility, and added humus help to reduce sand wireworms damage to cotton. Chlordane, DDT, and benzene hexachloride have shown promise in control of this and other species of wireworms on other crops. Additional research on the control of wireworms is needed.

Miscellaneous Insects

Salt-marsh caterpillar, *Estigmene acrea* (Drury): In cage tests 20 percent chlorinated camphene applied at the rate of 20 pounds per acre killed from 90 to 100 percent of the caterpillars. DDT, benzene hexacloride, TDE (DDD) and chlordane were each ineffective at normal rates of application.

In field tests in Arizona, a dust mixture containing 15 percent chlorinated camphene, 5 percent DDT, and 40 percent sulfur gave excellent control of the salt-marsh caterpillar on cotton. The dust mixture was applied at the rate of 20 pounds per acre.

Flea beetles: A 10 percent DDT dust has been found effective.

Cotton root aphids: Tartar emetic bait has been found effective. There has been no research on these insects in recent years.

Grape colaspis, Colaspis flavida (Say): Calcium arsenate, and DDT have given satisfactory control of this insect.

Cabbage looper, Trichoplusia ni (Hbn.): The cabbage looper and several other closely related species are at times serious pests of cotton in localized areas. Calcium arsenate is not a satisfactory control for these insects.

Investigations of the distribution, host plants, habits, and control of the species that attack cotton are needed.

Corn silk beetle, Luperodes brunneus (Crotch): This insect was reported from Jackson Parish, Louisiana in 1948. It appears sporadically as a pest on cotton in localized areas in several states. Little is known about this insect.

Cotton square borer, Strymon melinus (Hbn.): The cotton square borer occurs throughout the Cotton Belt. The injury caused by this insect to squares is often attributed to the bollworm.

Callarctia phyllira (Drury): This woolly bear caterpillar was a serious pest of cotton during 1948 in small areas in Arkansas, Louisiana, Mississippi, and Tennessee. No effective control is known.

Cotton Insect Survey

The cotton insect survey is considered a vital phase of the insect oontrol program. The survey is conducted in the major cotton-growing states, except Alabama, California, Missouri, and Tennessee. Engaged in this cooperative project are various State and Federal agencies, individuals, business firms, and others interested in cotton. The collection, assimilation, interpretation, and dissemination at weekly intervals of current information on abundance and location of injurious cotton insects has done much toward arousing interest in insect control. It is of great assistance in aiding growers, the insecticide industry, research, extension, and regulatory agencies in making a more concerted and successful fight against cotton insects. The extent and intensity of the coverage determines the value of the survey. It is recommended that the Cooperative Cotton Insect Survey be placed on a permanent basis and expanded to include all cotton producing areas.

Research Needs

More attention should be given to the fundamental factors involved in connection with the control of cotton insects. Many of these problems are common to practically all the Cotton Belt, but others are extremely variable and limited to smaller areas. Methods for conducting experiments should be coordinated as closely as possible so that results may be comparable.

Basic information is needed concerning:

1. Methods and equipment for the application of insecticides to cotton:
   a. Improved machinery and equipment for applying dusts and sprays.
   b. Methods used in applying insecticides.
   c. Use of aircraft for applying insecticides to cotton.
2. Insecticides:
   a. Comparative toxicity of different materials.
   b. How the insecticides kill.
   c. Effect of sublethal dosage upon insect reproduction and development.
   d. Effect of temperature, humidity, sunlight, and air currents upon effectiveness of insecticides.
   e. Improved formulations for insecticides, including compatibility.
   f. Improved techniques for testing insecticides.
   g. Effects of insecticides upon natural enemies of cotton insects.
   h. Effects of insecticides upon soils, plants, livestock, and wild life.
   i. Possibility of odor and taste contamination of food products by organic insecticides applied for control of cotton insects.
   j. The development of insect resistance to insecticides.
   k. Factors influencing deterioration of insecticides in storage.
   l. Effects of insecticides on honey bees and other insect pollinators.
   m. Relation of factors such as coverage, particle size, distribution and residual toxicity to cotton insect control.
   n. Application schedules.

Basic studies are needed concerning:

a. Effect of ecological factors, cropping systems, natural enemies, cultural practices, and plant nutrition upon cotton insect populations.
b. Correlation of insect control with seasonal development of the cotton plant and insect pests to obtain maximum protection with a minimum number of insecticide applications.
c. Potentialities of community cooperation in control of cotton insects.
d. Possibilities of gearing insect control to mechanical production of cotton.
e. Seasonal development and life histories of major cotton pests and others that are potentially injurious.
f. Possible insect vectors of cotton diseases.
g. Defoliation in relation to control of cotton insects.
h. Effect of early season infestations on subsequent development and yield of cotton.

Conferees at Baton Rouge, La., Conference

Entomologists and associated technical workers interested in cotton insects from the Agricultural Experiment Stations, Extension Services, and other state agencies in 12 cotton-growing States and the United States Department of Agriculture, and the National Cotton Council of America participated in the Cotton Insect Research and Control Conference at the Louisiana State University and Agricultural and Mechanical College, Baton Rouge, La., on November 8, 9, and 10, 1948. The 73 conferees representing these agencies are listed below.

<u>Alabama</u>

F. S. Arant, Entomologist, Agr. Expt. Sta., Auburn.
W. A. Ruffin, Entomologist, Agr. Ext. Serv., Auburn.

<u>Arkansas</u>

Dwight Isely, Entomologist, Agr. Expt. Sta., Fayetteville.
Charles G. Lincoln, Entomologist, Agr. Ext. Serv., Fayetteville.

<u>Georgia</u>

P. M. Gilmer, Entomologist, Ga. Coastal Plain Expt. Sta. and Bur. Ent. and Plant Quar., U. S. D. A., Tifton.
Loy Morgan, Asst. Entomologist, Ga. Coastal Plain Expt. Sta., Tifton.
G. M. Beckham, Entomologist, Ga. Agr. Expt. Sta., Experiment.
R. H. Washburn, Entomologist, Univ. of Ga., Athens.

<u>Illinois</u>

G. C. Decker, Entomologist, State Nat. Hist. Survey, Univ. of Ill., Urbana.

<u>Louisiana</u>

C. E. Smith, Entomologist, Agr. Expt. Sta., Baton Rouge.
A. L. Dugas, Assoc. Entomologist, Agr. Expt. Sta, Baton Rouge.
E. H. Floyd, Asst. Entomologist, Agr. Expt. Sta., Baton Rouge.
L. D. Newsom, Asst. Entomologist, Agr. Expt. Sta., Baton Rouge.
W. H. Gates, Head, Dept. of Zoology and Entomology, La. State Univ., Baton Rouge.
O. W. Rosewall, Dept. of Entomology, La. State Univ., Baton Rouge.
J. H. Roberts, Dept. of Entomology, La. State Univ., Baton Rouge.
H. B. Boudreaux, Dept. of Entomology, La. State Univ., Baton Rouge.
Edwin Lott, State Entomologist, Dept. of Agr., State Capitol, Baton Rouge.
S. J. McCrory, District Entomologist, State Dept. of Agr., Baton Rouge.
E. A. Cancienne, District Entomologist, State Dept. of Agr., Baton Rouge.
J. W. Bateman, Subject Matter Spec., La. State Univ., Baton Rouge.
H. B. Brown, Agronomist, La. State Univ., Agricultural Center, Room 131, Baton Rouge.
I. W. Carson, Assoc. Agronomist, Ext. Div., La. State Univ., Baton Rouge.

<u>Mississippi</u>

Clay Lyle, Entomologist, Agr. Expt. Sta., State Plant Bd. and Dean, School of Science, State College.
A. L. Hamner, Entomologist, Agr. Expt. Sta., State College.

Mississippi--Continued

L. C. Murphree, Ext. Entomologist, State College.

Henry Green, Delta Branch Expt. Sta., Stoneville.

B. J. Young, Vice Pres. and Prod. Mgr., Delta Pine and Land Company, Scott.

Missouri

Wilbur R. Enns, Agr. Expt. Sta., Univ. of Mo., Columbia.

North Carolina

W. M. Kulash, Entomologist, State Expt. Sta., Raleigh.

J. T. Conner, Jr., Ext. Entomologist, Raleigh.

Oklahoma

F. A. Fenton, Entomologist, State Expt. Sta., Okla. A. & M College, Stillwater.

C. F. Stiles, Ext. Entomologist, A & M College, Stillwater

South Carolina

J. A. Berly, Entomologist, Dept. of Entomology, Clemson.

J. G. Watts, Entomologist, Edisto Branch Expt. Sta., Blackville.

W. C. Nettles, Ext. Entomologist, Clemson.

L. M. Sparks, Jr., Ext. Specialist, Clemson.

Tennessee

W. W. Stanley, Assoc. Entomologist, Agr. Expt. Sta., Univ. of Tenn., Knoxville.

J. O. Andes, Ext. Spec. in Plant Path. and Entomology, Univ. of Tenn., Knoxville.

Texas

H. G. Johnston, Head, Dept. of Entomology, Texas A & M College, Agr. Expt. Sta. and Ext. Serv., College Station.

J. C. Gaines, Entomologist, Agr. Expt. Sta., College Station.

C. A. King, Jr., Ext. Entomologist, College Station.

Herman S. Mayeux, Ext. Entomologist, Assoc. County Agent, San Benito.

United States Department of Agriculture

Agricultural Research Administration

Bureau of Entomology and Plant Quarantine

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F. C. Bishopp, Asst. Chief, Washington, D. C.

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L. F. Curl, Div. of Pink Bollworm Control, Box 2749, San Antonio, Tex.

R. W. Harned, Div. of Cotton Insects, Washington, D. C.

R. C. Gaines, Div. of Cotton Insects, Tallulah, La.

M. T. Young, Div. of Cotton Insects, Tallulah, La.

G. L. Smith, Div. of Cotton Insects, Tallulah, La.

G. L. Garrison, Div. of Cotton Insects, Tallulah, La.

K. P. Ewing, Div. of Cotton Insects, Waco, Tex.

C. R. Parencia, Jr., Div. of Cotton Insects, Waco, Tex.

A. J. Chapman, Div. of Cotton Insects, Brownsville, Tex.

United States Department of Agriculture--Continued.

Agricultural Research Administration--Continued.

Bureau of Entomology and Plant Quarantine--Continued.

R. L. McGarr, Div. of Cotton Insects, San Benito, Tex.
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R. L. Walker, Div. of Cotton Insects, Florence, S. C.
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E. E. Ivy, Div. of Cotton Insects, College Station, Tex.
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S. L. Calhoun, Div. of Cotton Insects, Stoneville, Miss.
W. R. Smith, Div. of Cotton Insects, Stoneville, Miss.
K. L. Cockerham, Div. of Truck Crop and Garden Insects, Baton Rouge, La.
P. K. Harrison, Div. of Truck Crop and Garden Insects, Baton Rouge, La.

Bureau of Plant Industry, Soils, and Agricultural Engineering

D. C. Neal, Plant Pathologist, Cotton Diseases, Baton Rouge, La.
J. E. Hite, Cotton Specialist, Jackson, Miss.
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E. R. McGovran, Entomologist, Washington, D. C.

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M. P. Jones, Entomologist, Washington, D. C.

Production and Marketing Administration

H. H. Shepard, Entomologist, Insecticide Div., Washington, D. C.

National Cotton Council of America

C. L. Welch, Director, Production and Marketing Div., Memphis, Tenn.

Washington, D. C.
December 3, 1948